METHOD FOR MANUFACTURING A STRUCTURAL MEMBER OF A VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This application claims priority of Korean Application No. 10-2003-0026703, filed on April 28, 2003, the disclosure of which is incorporated fully herein by reference.

FIELD OF THE INVENTION

[002] The present invention relates to a method for manufacturing a structural member of a vehicle. More particularly, the method comprises the steps of preparing a structural member essentially consisting of Fe, C, Si, Mn, P, and S, which is suitable for heat treatment, pressing, and heat treating a portion of the structural member, where a supplementary reinforcement is required, for enhancing the strength of the structural member by means of direct-heating such as by high-frequency heating methods.

BACKGROUND OF THE INVENTION

[003] In general, structural members used in construction of a vehicle are manufactured by pressing and welding a high strength steel into a desired shape. Therefore, the high strength steel employed in manufacturing the structural members is typically required to be both weldable and formable.

[004] As shown in Fig. 6, structural members, for example, a front-side member 100, a front-cross member 200, a center floor reinforcing member 300, a front bumper member (rail) 400 and a rear bumper member (rail) 500 are disposed and connected by welding at the front, rear, and sides of a vehicle's body frame. These structural members typically serve as safety means, in case of a collision, by absorbing the impact of the collision. In addition, the structural members also serve as supporting elements in which other elements or parts of the vehicle are installed or mounted.

[005] Accordingly, the improvement of the mechanical characteristics of the structural members of a vehicle is one of the most important factors of vehicle safety design. Furthermore, it is also an important factor in reducing fuel consumption of the vehicle by reducing the weight of the vehicle. Over the years, efforts for improving the mechanical characteristics of the structural members of a vehicle have been steadily conducted. Generally, there are two ways to improve the mechanical characteristics of

structural members. The first is to employ high-strength materials in the manufacturing process and the other is to change the shapes of the structural members in order to change the strength.

[006] For example, Japanese unexamined patent publication No. S61-15128, and Japanese unexamined patent publication No. H03-10049 disclose methods for manufacturing a high strength steel plate by adjusting the composition or structure of the steel used in the plate. These inventions disclosed in the cited references relate to a transformation of the structure of the steel for improving the strength of the steel plate. However, such inventions are disadvantageous in that the surface quality of the steel plate is not uniform. Furthermore, it also becomes difficult to form the material by way of a press due to the high-strength property of the steel. Thus, the method utilizing a change in shape of structural members has been generally adopted as the method of choice to improve the strength of structural members.

[007] Thereafter, supplemental elements are overlaid and spot-welded to each other where further reinforcement is required. The supplemental elements, which are conventionally thick steel plates, improve the strength of the structural members. In the case of manufacturing a complexly shaped structural member a low-strength steel plate, for example 34-45kgf/mm^2, is inevitably used in the pressing process. As a result, more supplemental elements are required to be overlaid and welded to the structural member in order to reinforce the strength, resulting in an increase in processes and manufacturing cost.

SUMMARY OF THE INVENTION

[008] In one embodiment, the present invention provides a method for manufacturing a structural member of a vehicle. The method includes the steps of preparing a steel essentially consisting of Fe, C, Si, Mn, P, and S, for forming a structural member. The structural member is formed by pressing the steel and heat treating a portion of the structural member where a supplementary reinforcement is required for enhancing the strength of the structural member.

[009] In a preferred embodiment, the present invention provides a method for manufacturing a structural member of a vehicle. The method comprises the steps of preparing a steel plate essentially consisting of Fe, 0.20-0.25 weight% of C, not more than 0.3 weight% of Si, 1.0-1.2 weight% of Mn, not more than 0.02 weight% of P, and not more than 0.005 weight% of S. Next, the step of forming a structural member with this steel by pressing the steel and heat treating a portion of the structural member where

a supplementary reinforcement is required for enhancing the strength of the structural member by means of direct-heating, such as, by high-frequency heating methods.

[0010] In the preferred embodiment, the heat treating process by means of direct-heating is conducted under the conditions of: a frequency of 15-25kHz, and a power of 40-60kW for a heating duration of 20-40 sec. and a cooling duration of 15-25 sec. where the flow rate of coolant is 1000-1500 L/min. and a temperature of direct-heating of 900℃ or higher.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The aforementioned aspects and other features of the present invention will be explained in the following description, taken in conjunction with the accompanying drawings, wherein:

[0012] Fig. 1 shows a structural member of a vehicle according to an embodiment of the present invention, whose certain parts are reinforced;

[0013] Fig. 2 illustrates current flow of direct-heating according to an embodiment of the present invention;

[0014] Fig. 3 is a microscopic view of a structure of high-strength steel, which has undergone heat treatment (direct-heating) according to an embodiment of the present invention;

[0015] Fig. 4 is a microscopic view of structure of moderate-strength steel, which has undergone heat treatment (direct-heating) according to an embodiment of the present invention;

[0016] Fig. 5 is a microscopic view of structure of steel, which has not undergone heat treatment according to an embodiment of the present invention; and

[0017] Fig. 6 shows various kinds of structural members that are used in a conventional vehicle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] Hereinafter, a preferred embodiment of the present invention is described in detail with reference to the accompanying drawings.

[0019] The present invention relates to a method for manufacturing a structural member of a vehicle. The method includes, at least, a step of heat-treating a portion of the structural member where a supplementary reinforcement is required for enhancing the strength of the structural member, such that a structural member possessing light weight and improved endurance can be achieved at a minimal cost.

[0020] According to an embodiment, a steel used for manufacturing a structural member comprises primarily Fe, 0.20-0.25 weight% of C, not more than 0.3 weight% of Si, 1.0-1.2 weight% of Mn, not more than 0.02 weight% of P, and not more than 0.005 weight% of S.

[0021] In the above-listed element, C serves to adjust the strength and hardenability of the steel. Due to excessive strength, if the amount of C exceeds 0.25 weight% it is not suitable for forming a structural member by means of press forming. Furthermore, if the amount of C is less than 0.20 weight%, the steel is not able to satisfy the requirements of hardenability. Thus, the preferable amount of C is between about 0.20-0.25 weight%.

[0022] Si, serving as a deoxidizer, is preferably limited to less than 0.3 weight% because the formability of the steel is decreased if the amount of Si exceeds 0.3 weight%.

[0023] Mn, a solid-solution hardening elements, is the element that is necessary to improve a strength of the steel. Preferably, the amount of Mn should be limited between about 1.0 weight% and 1.2 weight% for obtaining proper strength of the steel.

[0024] The elements, P and S are contained as incidental impurities. Preferably, in the light of formability and ductility of the steel, the amount of P and S should be limited to less than about 0.02 weight% and 0.005 weight%, respectively.

[0025] The material comprising the above-described elements is high-strength steel having a tensile strength of about 38-55kgf/mm^2, and a normal structure (ferrite-pearlite) at room temperature. The manufacturing method of a structural member of a vehicle according to present invention includes steps of a forming process and heat-treating process, by which the present invention is characterized.

[0026] According to an embodiment of the invention, through a forming process by means of a press the steel plate is formed into a desired shape. Thereafter, the steel plate is heat treated at a portion of the structural member where a supplementary reinforcement is required. This enhances the strength of the structural member by means of direct-heating, such as by high-frequency heating methods. These methods replace conventional spot-welding of supplemental elements. In a preferred embodiment of the present invention, the direct-heating is conducted under the conditions including: a frequency of 15-25kHz, a power of 40-60kW, a heating duration of 20-40 sec, a cooling duration of 15-25 sec, a flow rate of coolant of 1000-1500 L/min, and a temperature of direct-heating of 900℃ or higher.

[0027] If the frequency is not in the range from 15kHz to 25kHz, the result is a partially melted steel plate. The heating duration, the cooling duration, and the flow rate of coolant are important parameters in controlling deformation of the structural member. The direct-heating temperature should be over 900℃ because this is a minimum temperature that can cause transformation of the structure of steel.

[0028] Figs. 3 and 4 show parts of a structural member that have been heat-treated by direct-heating. The parts show transformation into bainite or martensite. On the other hand, the part of the structural member that is not heat-treated remains in its normal structure (ferrite-pearlite structure) as shown in Fig. 5.

[0029] In an embodiment of the present invention, as shown in Fig. 1, the parts IH-1, IH-4, and IH-5 which are to mechanically support a vehicle with minimum deformation during a collision are preferably provided with martensite structure having a tensile strength of between about 120-160 kgf/mm^2. The parts IH-2 and IH-3 which are intended to absorb an impact by deforming during a collision are provided with ferrite and bainite structure and have a tensile strength of between about 80-120 kgf/mm^2. Such variations of steel structure can be achieved by adjusting heating temperature, heating duration, and cooling duration.

[0030] With the method for manufacturing a structural member according to the present invention, it is possible to obtain a mechanically improved structural member without additionally attaching support elements. Therefore, the structural member can weigh less overall with minimum sub-parts and less processing.

[0031] Hereinafter, the present invention will be described in detail in an exemplary manner, however, it is not intended to limit the scope of the present invention.

Example

[0032] Table 1 shows chemical compositions, by weight%, of high-strength steel of an example of the present invention and a comparative sample. According to this example, a structural member of a vehicle was formed by pressing the high-strength steel. Thereafter, the direct-heating according to the present invention was conducted under the condition of: a frequency of 15-25kHz, a power of 40-60kW, a heating duration of 20-40 sec, a cooling duration of 15-25 sec, a flow rate of coolant of 1000-1500 L/min, and a temperature of direct-heating of 900℃ or higher.

Comparative example

[0033] With the high-strength steel comprising a chemical composition for a comparative example as shown in the table 1, a structural member of a vehicle was

prepared without heat-treatment. Thereafter, supplemental elements are spot-welded where the reinforcement is required.

[0034] Table 1

	C	Si	Mn	P	S	Fe
Example	0.2-0.25	< 0.3	1.0-1.2	< 0.02	< 0.005	Balance
Comparative example	0.023	0.02	0.14	0.080	0.011	Balance

Experimental example

[0035] Mechanical properties of test pieces extracted from the example and the comparative example were measured and the results are shown in table 2.

[0036] Table 2

	Tensile strength (kgf/mm^2)		Yield strength (kgf/mm^2)		Elongation (%)		Weight (kg)
	High-Strength	Modertate-Strength	High-Strength	Modertate-Strength	High-Strength	Modertate-Strength	
Example	120-160	80-120	100-140	60-90	4-8	5-10	5
Comparative Example	30-40		20-30		30-40		8

[0037] As shown in table 2, it would be appreciated that the mechanical properties such as tensile strength, yield strength, elongation rate and weight of the structural member according to the present invention are superior to those of the conventional spot-welded structural member. In view of the foregoing, a structural member manufactured according to the present invention is lighter by about 30% than that manufactured by a conventional method.

[0038] As described above, the present invention is advantageous in that a spot-welding process of additional supplementary elements can be eliminated by heat-treating the portion that the additional reinforcement is required, so that the cost involved in the spot-welding process and the overall weight of a vehicle can be much reduced.